ORIGINAL APPLICATION AS TRANSLATED

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Signature Date

Specification

1. TITLE OF THE INVENTION

VAPOR HEAT INSECT KILLING APPARATUS FOR MEDITERRANEAN FRUIT FLY, ORANGE SMALL FRUIT FLY, QUEENSLAND FRUIT FLY AND MELON FRUIT FLY OR THE LIKE

2. BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

This invention relates to a vapor heat insect killing apparatus for a so-called fruit fly or the like such as a Mediterranean fruit fly, an orange small fruit fly, a Queesland fruit fly and a melon fruit fly or the like grown at the fruits.

RELATED ART

As this kind of vapor heat insect killing apparatus, it has been well known in the related art to provide an apparatus in which a fruit processing chamber for circulating and flowing vapor heat in a lateral direction is provided with a fruit storing unit where vapor is forcedly flowed from below in a vertical direction, vapor heat is contacted with the fruits (raw fruits) stored in the fruit storing unit to kill eggs or seeds of the fruit fly grown at the raw fruit (for example,

refer to Patent Document 1 (As the example of the related art, gazette of Japanese Patent Publication No. Sho 61-1094 (pages 1 to 2, Figs. 1 and 3 is cited)).

The aforesaid related art is a system in which the fruit storing units having a plurality of differential pressure fans are installed in the fruit processing chamber, vapor (saturated vapor) generated by a common vapor supplying means and a heat exchanger means is circulated and flowed by a forced circulating fan to these fruit storing units, and in turn there are provided a temperature sensor for sensing a temperature in the fruit processing chamber, a temperature sensor for sensing a temperature at the center of a fruit and a relative humidity sensor, the vapor supplying means and the heat exchanger means are controlled in response to the detected signal of the temperature sensor for sensing the central temperature of the fruit, after the temperature is increased up to the predetermined central temperature of the fruit, an operation at the central temperature of the fruit is continued for a predetermined time, the vapor heat processing is carried out to kill eggs or seeds of the fruit fly grown at the fruit

In this related art system, the fruits harvested at each of growing districts and each of the farmers are classified in reference to an amount of moisture contained in the fruit,

a degree of ripen and further classified for every several hundred kilograms of sizes at each of the pallets and mounted.

Accordingly, in the case that the vapor heating process is to be carried out, it is practically found that the central temperature of the fruits is not increased under a uniform increasing rate due to the amount of moisture, the degree of ripen and the size, and an increasing of the central temperature of the fruits in a certain fruit storing unit is delayed as compared with an increasing of the central temperature of the fruits in another fruit storing unit.

However, the related art has no description at all about a procedure for overcoming the present situation. Due to this fact, the fruit of which temperature is increased up to a predetermined central temperature of the fruits in the fruit-storing unit has a continued vapor heating process for a longer hour under a high temperature region for a period in which the fruit in the fruit-storing unit delayed in the increasing of the central temperature of the fruits is treated with vapor heat, resulting in that the fruit suffers from some so-called thermal troubles such as shrunk or its lost color luster or resiliency.

3. SUMMARY OF THE INVENTION

This invention has been invented in reference to aforesaid related art circumstances and it is an object of the present invention to provide a vapor heat insect killing apparatus for a Mediterranean fruit fly, orange small fruit fly, a Queensland fruit fly and melon fruit fly or the like in which an increasing in temperature at the fruit in the fruit storing unit where the central temperature of the fruits is delayed in its increasing is made fast, an increasing reach time of each of the fruits stored in each of the fruit storing means up to a predetermined central temperature of the fruits is set to a substantial same value so as to prevent any thermal troubles in advance.

The present inventors et al. have studied this theme earnestly and found that the higher a relative humidity under an insect killing treatment with vapor, the higher a thermal conductivity, the thermal conductivity may contribute to an increasing in the central temperature of the fruits, the more an increased amount of contact of the saturated vapor per unit time against the fruit, similarly, the higher the thermal conductivity for the fruit, and the thermal conductivity may contribute to an increasing in the central temperature of the fruits and have invented the present invention.

That is, the present invention is a vapor heat insect

killing apparatus for a Mediterranean fruit fly, orange small fruit fly, a Queensland fruit fly and melon fruit fly or the like, wherein a plurality of fruit storing units for storing pallets having some fruits stored therein are arranged in a fruit processing chamber; air conditioner chambers provided with a heat exchanging means and a forced circulating means are communicated for every one of a plurality of fruit storing units; a plurality of air circulation units for independently and forcedly air blowing air from below to each of the fruit storing units are constituted; each of the air circulating units is provided with a vapor supplying means for saturated vapor and the like, a central temperature of the fruits sensing means for sensing a temperature at the center of the fruit, a temperature sensing means for sensing a temperature, and a relative humidity sensing means for sensing a relative humidity; and the relative humidity of the saturated vapor passing in each of the fruit storing units can be controlled while controlling a vapor supplying amount by the vapor supplying means and a heat exchanging rate of the heat exchanging means in response to the detected signal of the central temperature of the fruits sensing means for every each of the air circulating units.

Then, as one practical example the present invention,

the vapor supplying means and the heat exchanger means at the time of increasing in temperature are controlled in reference to a detected signal of the fruit temperature sensing means in the case that an increasing in temperature of the central temperature of the fruits in a certain fruit storing unit is delayed as compared with an increasing in temperature of the central temperature of the fruits in another fruit storing unit, a relative humidity of the saturated vapor passing in the fruit storing units storing the fruits where the increasing in temperature of the central temperature of the fruits is delayed is increased so as to cause the central temperature of the fruits to be made fast.

[Table 1] Proof Data

	12:30 Central Temperature °C	Relative Humidity %RH	Inside Temperature °C	13:00 Central Temperature °C	Relative Humidity %RH	Inside Temperature °C	13:30 Central Temperature °C	Relative Humidity %RH	Inside Temperature °C	14:00 Central Temperature °C	Relative Humidity %RH	Inside Temperature °C
(1)	27.0	59.6	28.3	30.8	95.1	45.8	39.2	95.3	48.2	44.3	95.4	48.2
(2)	26.8	59.4	28.2	31.0	95.0	45.9	39.4	95.1	48.1	44.3	95.3	48.1
(3)	26.0	59.3	28.1	30.3	95.0	45.8	38.8	95.4	48.2	44.0	95.5	48.2
(4)	27.5	59.3	28.3	31.9	95.0	45.7	39.9	95.2	48.2	44.4	95.3	48.2
(5)	26.5	59.2	28.1	30.1	95.1	45.6	39.1	95.4	48.1	44.4	95.5	48.1
ΔT				1.8			1.1			0.4		

	14:50 Central Temperature °C	Relative Humidity %RH	Inside Temperature °C	15:05 Central Temperature °C	Relative Humidity %RH	Inside Temperature °C	15:55 Central Temperature °C	Relative Humidity %RH	Inside Temperature °C
(1)	47.1	96.0	48.1	47.4	96.0	48.0	37.7	71.0	29.4
(2)	47.1	96.1	48.2	47.4	96.1	48.0	35.7	72.0	28.6
(3)	47.0	96.0	48.1	47.4	96.0	48.0	36.3	74.0	29.0
(4)	47.1	96.2	48.2	47.4	96.1	48.0	34.8	73.0	28.5
(5)	47.1	96.0	48.1	47.4	96.0	48.0	35.1	76.0	28.3
ΔT	0.1			0					

The aforesaid Table 1 is a proof data in which a mango is applied as an example to be insect killed. As shown in Fig. 2, this is a vapor insect killing apparatus A constituted such that air chambers 21 provided with a heat exchanging means 4 and a forced circulating means 3 for each of a plurality of fruit storing units 31 ((1), (2), (3), (4) and (5)) are communicated to each other to constitute a plurality of (5) air circulating units 11.

In this Table 1, each of (1), (2), (3), (4) and (5) corresponds to the fruit storing units 31 within each of the air circulation units 11. Each of 12:30, 13:00, 13:30, 14:00, 14:50, 15:05, and 15:55 denotes a measuring time, respectively. 15:05 denotes a time starting a natural cooling, 15:55 denotes its finishing time and 12:30 denotes a starting time for a vapor heating process, respectively. When the operation is started at 12:30, the temperature in each of the air circulating units 11 is increased while the heat exchangers 5 are being controlled during a period in which the relative humidity in each of the air circulating units 11 is gradually increased under a predetermined increasing mode (a predetermined increasing rate) in the same manner as that of the related art vapor heating insect killing method.

As already known in the related art, it has been known

in the case of an orange small fruit fly and a melon fruit fly or the like that some seeds and maggots grown at a fruit are died by the vapor heating process (for example, in the case of mango, the central temperature of the fruits of 47.0°C, relative humidity of 90 to 100%RH, and a processing time 15 minutes).

It is of course apparent that this vapor heating process is made different in reference to the type of a fruit.

Duration time of about 2 hours to 3 hours is taken under a predetermined increasing mode from the starting of this vapor heat processing, the central temperature of the fruits is gradually increased up to 47.0°C and the relative humidity is also gradually increased up to 95%RH or more, and the process is kept for 15 minutes while the relative humidity is kept as it is.

In Table 1, 13:00, 13:30, 14:00 and 14:50 denote measuring times in which the central temperature of the fruits is gradually increased up to 47.0°C and the relative humidity is gradually increased up to 95%RH or more. Then, the central temperature is a central temperature of the fruit in each of the air circulation units 11, the relative humidity is a relative humidity in each of the air circulation units 11, the temperature within the unit is a temperature in each of

the air circulation units 11, ΔT denotes a temperature difference between the maximum central temperature of the fruits and the minimum central temperature of the fruits among each of the air circulation units 11, respectively.

The central temperature of the fruits in each of the fruit storing units 31 (1), (2), (3), (4) and (5) at the measuring time of 13:00 in which 30 minutes elapse after starting the vapor heating operation has a certain disturbance ranging from 30.1°C to 31.9°C. A temperature difference at these central temperature of the fruits is 1.8°C.

Then, it has become apparent that the intermittent atomization time for vapor in regard to the fruit storing units 31(1), (2), (3) and (5) showing a certain delay in increasing of the central temperature of the fruits is increased as for the fruit storing unit (4) storing the fruit showing the maximum central temperature of the fruits, a heat exchanging rate of the heat exchanger means 4 is increased and the relative humidity is increased until 14:00, resulting in that the central temperature of the fruits within the fruit storing units 31 (1), (2), (3) and (5) approaches the central temperature of the fruits in the fruit storing unit 31(4) and then the temperature difference converges to 0.4°C.

In the case of the present invention, when the

temperature difference in respect to the maximum central temperature of the fruits becomes 0.5°C (a set value) or more, it is acknowledged such that the air circulation unit 11 storing the fruit having a lower central temperature of the fruits than the set value shows a certain delay in increasing in regard to the air circulation unit 11 storing the fruit of the maximum central temperature of the fruits at the measuring time, resulting in that the intermittent atomization time for vapor per predetermined time is increased and at the same time a temperature of the heat exchanger means 4 is increased in such a way that the temperature in the air circulation unit 11 may not be decreased and the relative humidity may be increased in respect to the air circulation unit 11 storing the fruit of the maximum central temperature of the fruits, and the relative humidity is increased in regard to the air circulation unit 11 storing the fruit of the maximum central temperature of the fruits. For example, when a temperature difference against the maximum central temperature of the fruits is 0.5°C (a set value) or more at the time of measuring time of 13:00, as an intermittent atomization of vapor for 15 seconds for every 1 minute to the fruit storing unit 31 storing the lower temperature fruit than the set value in respect to the fruit storing unit 31 for storing the fruit of the maximum central

temperature of the fruits, the vapor is intermittently atomized for 30 to 50 seconds to increase a supplying amount of vapor, and as a heating calorie of 5 Kw/h of the heat exchanger means (heater) 4, it is increased by 1 Kw/h to several Kw/h and its operation is continued during a time ranging from 13:00 to 14:00.

The number of vapor atomization per the predetermined time is increased in proportion to a temperature difference, and an increasing rate of the heat exchanging means 4 is in proportion to the temperature difference in such a way that an inside temperature in the air circulation unit 11 may not be cooled.

The time 13:30 denotes a measuring time during the operation and even at this stage, the temperature difference converges down to 1.1°C.

It is assumed that the saturation vapor at the fruit surfaces in the fruit storing units 31(1), (2), (3) and (5) is increased and a thermal conductivity for an increased central temperature of the fruits is improved.

The set value (for example, 0.5°C) of the central temperature of the fruits is always chased, the vapor supplying means C4 and the heat exchanger means 4 in the corresponding fruit storing unit 31 are controlled as described above every

time a value more than the set value is detected at each of the measuring times as a temperature difference in respect to the maximum central temperature of the fruits, a vapor atomization amount for the fruit storing unit 31 to be targeted and a heating calorie of the heat exchanger means 4 are increased and the operation is continued in such a way that the temperature difference converges to a value lower than the set value by 0.5°C.

When the central temperature of the fruits at each of the fruit storing units 31 converges to a value lower than the set value at each of the measuring times, the operation returns back to an increasing mode controlled by the control unit, each of the vapor supplying means C4 and each of the heat exchanger means 4 are controlled by the control unit, and the relative humidity and the inside temperature are increased at the predetermined increasing rate.

Then, the vapor heated state is kept for 15 minutes from the measuring time 14:50 where the central temperature of the fruits converges to 47.0 to 47.1°C under a relative humidity of about 96%RH, the state is cooled automatically from the time 15:05 to 15:55 and the vapor heating process is completed.

A controlling operation for controlling each of the vapor supplying means C4 and the heat exchanger means 4 and increasing

their temperature at a predetermined increasing rate is set through an inputting at a memory unit of the control unit in response to the kind of fruit, and the set value of the central temperature of the fruits, the aforesaid intermittent atomization time and the increased heating calorie of the heat exchanger means 4 and the like can be similarly changed through inputting into the memory unit of the control unit in response to the kind of fruit to be processed.

In the case of Claims 1 and 2, a vapor supplying amount provided by the vapor supplying means and a heat exchanging rate of the heat exchanger means are controlled in response to a detected signal of the central temperature of the fruits sensing means for every air circulating unit, a relative humidity of saturated vapor passing in each of the fruit storing units is controlled, and when an increasing of the central temperature of the fruits in one fruit stored in a certain fruit storing unit is delayed as compared with the other fruit stored in another fruit storing unit in reference to a contained moisture amount or a degree of ripen and a size or the like, the vapor supplying means and the heat exchanger means are controlled in response to the sensing signal of the fruit temperature sensing means to increase the relative humidity, thereby the thermal conductivity is increased and the

increasing rate of the central temperature of the fruits is increased and then an increasing reaching time of the fruit stored in each of the fruit storing units to a predetermined central temperature of the fruits can be set substantially in a concurrent time.

That is, the central temperature of the fruits in each of the fruit-storing units is detected and monitored individually by the fruit temperature sensing means. Then, in the case that an increasing of the central temperature of the fruits of a fruit stored in a certain fruit storing unit is delayed more than an increasing of the central temperature of the fruits of a fruit stored in another fruit storing unit, the intermittent atomization amount is increased from the vapor supplying means and at the same time a heat exchanging rate of the heat exchanger means is increased (a heating capacity of a heating source is increased). With such an operation as above, a relative humidity of saturated vapor passing through the fruit-storing unit is increased to cause the thermal conductivity to be increased and an increasing rate of the central temperature of the fruits can be increased.

In addition, a plurality of fruit storing units for storing pallets having some fruits installed therein are arranged within the fruit processing chamber, the air

conditioner chambers provided with the heat exchanging means and the forced circulation means are communicated with the fruit processing chamber and at the same time, a flowing air blower means for flowing air from below in each of the fruit storing units is arranged in each of the fruit storing units to enable the vapor to forcedly circulate in each of the fruit storing units and the air conditioner chambers, the fruit processing chambers are provided with a saturated vapor supplying means, a temperature sensing means for sensing a temperature and a relative humidity sensing means for sensing a relative humidity, each of the fruit storing units is provided with a central temperature of the fruits sensing means for sensing a temperature of the center of the fruit, and in the case that an increasing in temperature of the central temperature of the fruits sensing means arranged at each of the fruit storing units is delayed more as compared with an increasing in temperature of the central temperature of the fruits in another fruit storing unit, the air blower means for flowing air is controlled in response to the sensing signal of the fruit temperature sensing means, a blowing amount of the saturated vapor flowing in the fruit storing unit having the delayed increasing in temperature of the central temperature of the fruits is increased to cause the increasing

in the central temperature of the fruits to be made fast (Claim 3).

[Table 2] Proof Data

	15:16 Central Temp. °C	Air Volume %	Relative Humidity %RH	Inside Temp. °C	16:14 Central Temp. °C	Air Volume %	Relative Humidity %RH	Inside Temp. °C	16:44 Central Temp. °C	Air Volume %	Relative Humidity %RH	Inside Temp. °C	17:14 Central Temp. °C	Air Volume %	Relative Humidity %RH	Inside Temp. °C
(1)	29.0	80	63.3	33.2	33.9	90	95.2	45.8	40.5	85	95.3	47.7	44.6	85	95.4	47.9
(2)	32.3	80	63.3	33.2	34.3	85	95.2	45.8	40.5	85	95.3	47.7	44.6	85	95.4	47.9
(3)	30.8	80	63.3	33.2	35.1	80	95.2	45.8	41.4	80	95.3	47.7	45.0	80	95.4	47.9
(4)	30.3	80	65.9	33.2	33.8	90	95.3	46.0	40.4	85	95.4	48.0	44.6	85	95.5	48.0
(5)	30.0	80	65.9	33.2	33.9	90	95.3	46.0	40.6	85	95.4	48.0	44.7	85	95.5	48.0
ΔT					1.3				1.0				0.4			

	17:44 Central Temp. °C	Air Volume %	Relative Humidity %RH	Inside Temp. °C	18:05 Central Temp. °C	Air Volume %	Relative Humidity %RH	Inside Temp. °C	18:20 Central Temp. °C	Relative Humidity %RH	Inside Temp. °C	19:04 Central Temp. °C	Relative Humidity %RH	Inside Temperature °C
(1)	46.5	80	95.5	47.9	47.0	80	95.5	48.0	47.2	95.2	47.9	29.1	75.2	29.7
(2)	46.6	80	95.5	47.9	47.0	80	95.5	48.0	47.2	95.2	47.9	29.7	75.2	29.7
(3)	46.7	80	95.5	47.9	47.2	80	95.5	48.0	47.4	95.2	47.9	36.1	75.2	29.7
(4)	46.6	80	95.6	48.0	47.2	80	95.6	48.1	47.5	95.3	48.0	37.3	74.0	29.5
(5)	46.7	80	95.6	48.0	47.2	80	95.6	48.1	47.5	95.3	48.0	36.8	74.0	29.5
ΔT	0.2				0.2				0.3					

The aforesaid Table 2 is similarly a proof data in which a mango is applied as an example to be insect killed. In this Table 2, each of (1), (2), (3), (4) and (5) corresponds to the fruit storing units stored in one common fruit processing chamber. As shown in Fig. 5, five fruit storing units 31 ((1), (2), (3), (4) and (5)) are stored in one common fruit processing chamber 1. Air conditioning chambers 21 provided with a heat exchanging means 4 and a forced circulating means 3 are communicated with the fruit processing chamber 1 so as to constitute the vapor heat insect killing apparatus A.

Each of 15:16, 16:14, 16:44, 17:14, 17:44, 18:05, 18:20, and 19:04 denotes a measuring time, respectively. 18:20 denotes a time starting a natural cooling, 19:04 denotes its finishing time and 15:16 denotes a starting time for a vapor heating process, respectively. When the operation is started at 15:16, the temperature in the fruit processing chamber 1 is increased while the heat exchangers 4 are being controlled during a period in which the relative humidity in the fruit processing chamber 1 is gradually increased under a predetermined increasing mode (a predetermined increasing rate) in the same manner as that of the related art vapor heating insect killing method.

In Table 2, 16:14, 16:44, 17:14, 17:44 and 18:05 denote measuring times in which the relative humidity is gradually

increased up to 95%RH or more. Then, the central temperature is a central temperature in each of the fruit storing units 31, the relative humidity is a relative humidity in the fruit processing chamber 1, the temperature within the chamber is a temperature in the fruit processing chamber, the air volume is an air volume of an air blower means (fan) 9 for flowing air (a rate against the maximum capability), ΔT denotes a temperature difference between the maximum central temperature of the fruits and the minimum central temperature of the fruits among each of the fruit storing units 31, respectively.

The inside temperature in the fruit processing chamber 1 and the relative humidity are increased under the predetermined increasing mode in the same manner as that found in Table 1 while each of the vapor supplying means C4 and the heat exchanger means 4 is controlled under the control of the control unit.

The central temperature of the fruits in each of the fruit storing units 31 (1), (2), (3), (4) and (5) at the measuring time of 16:14 in which one hour elapses after starting the vapor heating operation has a certain disturbance ranging from 33.8°C to 35.1°C. A temperature difference at these central temperature of the fruits is 1.3°C.

Then, it has become apparent that an air blowing capability of the air flowing air blower means (fan) 9 arranged at the corresponding fruit storing unit 31 in the fruit storing units 31 (1), (2), (4) and (5) showing a delay in increasing of the central temperature of the fruits against the fruit storing unit 31 (3) storing the fruit of the maximum central temperature of the fruits, resulting in that the central temperature of the fruits within the fruit storing units 31 (1), (2), (4) and (5) approaches the central temperature of the fruits in the fruit storing unit 31(3) within one hour up to 17:14 and then the temperature difference converges to 0.4°C.

In the case of the present invention, when the temperature difference in respect to the maximum central temperature of the fruits becomes 0.5°C (a set value) or more, it is acknowledged such that the fruit storing unit 31 for storing the fruit of lower temperature than the set value at the central temperature of the fruits has a certain delay in increasing at the measuring time in respect to the fruit storing unit 31 for storing the fruit of the maximum central temperature of the fruits, a feeding amount of the air blowing means (fan) 9 for flowing air is controlled so as to cause a heating amount of the saturated vapor at the surface to be increased more

than that of the fruit in the fruit storing unit 31 storing the fruit of the maximum central temperature of the fruits. For example, when a temperature difference against the maximum central temperature of the fruits is 0.5°C (a set value) or more at the measuring time of 16:14, an air blowing capability of the air blower means (fan) 9 for flowing air at the fruit storing unit 31 for storing fruit of low temperature by more than the set value is increased from that of the normal operation (80%) and then the operation is continued for one hour until 17:14.

In the related art, a feeding amount of the air blower means (fan) 9 for flowing air is kept constant (80%) at the time of increasing mode described above.

The air blowing capability of the air blower means (fan) 9 for flowing air described above is set in proportion to the temperature difference.

In Table 2, the time 16:44 denotes a measuring time during the operation and even at this stage, the temperature difference converges down to 1.0°C.

It is assumed that the heating amount at the fruit surfaces in the fruit storing units 31(1), (2), (4) and (5) is increased and a thermal conductivity for an increased central temperature of the fruits is improved.

The set value (for example, 0.5°C) of the central temperature of the fruits is always chased, the air blower means (fan) 9 for flowing air in the corresponding fruit storing unit 31 is controlled as described above every time a value more than the set value is detected at each of the measuring times as a temperature difference in respect to the maximum central temperature of the fruits, and the operation is continued.

In Table 2, there is shown a case that an air blowing capability of the air blower means (fan) 9 for flowing air in the fruit storing units 31(1), (2), (4) and (5) is set to 85% for 30 minutes ranging from 17:14 to 17:44, and the operation is performed and the temperature difference is converged down to 0.2°C.

When the central temperature of the fruits at each of the fruit storing units 31 converges to a value lower than the set value at each of the measuring times, the operation returns back to an increasing mode controlled by the control unit, each of the vapor supplying means C4, the heat exchanger means 4 and the air blower means 9 for flowing air and the like are controlled under a control of the control unit, and the relative humidity and the inside temperature are increased at the predetermined increasing rate.

Then, the vapor heated state is kept for 15 minutes from the measuring time 18:05 where the central temperature of the fruits converges to 47.0 to 47.2°C under a relative humidity of about 95.5%RH, the state is cooled automatically from the time 18:20 to 19:44. The air blowing capability of the air blower means (fan) 9 for blowing air at the time of keeping state is set to 80%.

A controlling operation for controlling each of the vapor supplying means C4, the heat exchanger means 4 and the air blower means 9 for flow air and for increasing their temperature at a predetermined increasing rate is set through an inputting at a memory unit of the control unit in response to the kind of fruit, and the set value of the central temperature of the fruits, and the increased air amount (a feeding amount) of the aforesaid air blower means 9 for flowing air and the like can be similarly changed through an inputting into the memory unit of the control unit in response to the kind of fruit to be processed.

In the case of Claim 3, when the fruit stored in a certain fruit storing unit shows a delayed increasing of the central temperature of the fruits in respect to the fruit stored in another fruit storing unit in reference to a contained moisture amount or a degree of ripen and a size or the like, a feeding

amount per unit time of the saturated vapor flowing in the fruit storing unit having a delayed temperature increasing of the central temperature of the fruits is increased on the basis of the sensing signal of the fruit temperature sensing means, resulting in that an increasing reach time up to the predetermined central temperature of the fruits of the fruit stored in each of the fruit storing units can be performed substantially in a concurrent time.

That is, the central temperature of the fruits in each of the fruit-storing units is sensed and monitored individually by the fruit temperature sensing means. Then, in the case that an increasing of the central temperature of the fruits of a fruit stored in a certain fruit storing unit is delayed more than an increasing of the central temperature of the fruits of a fruit stored in another fruit storing unit, the blown amount of saturated vapor is increased by the air blower means for flowing air to increase a heating amount and then an increasing rate at the central temperature of the fruits can be set high.

The results in the case of Table 1 and Table 2 showed that the maggot and seeds of fruit fly or the like grown at a fruit were dead without producing any shrunk, damaging any color luster or resiliency.

In regard to this fact, the aforesaid set value is only one example, and when it is set to 1.5°C or more, it may lead to the fact that the central temperature of fruits stored in another fruit storing unit is rapidly increased and this is not preferable.

Then, the set value may be set to a value smaller than 0.5°C.

In addition, when the set value is sensed by not only setting the measuring time shown in Table 1 and 2, but also setting the measuring time in a small stepwise manner or continuously measuring it so as to sense the set value, it may also be applicable to employ a control system starting a controlling operation.

The present invention has been constructed as described above, so that the present invention has the following advantages.

[First aspect]

When the fruits stored in a certain fruit storing unit show a slow increasing in the central temperature of the fruits in respect to the fruits stored in another fruit storing unit due to their contained moisture volume, degree of ripen and size or the like, the vapor supplying means and the heat exchanger means are controlled to cause the relative humidity

to be increased and the increasing in temperature to be made fast and thus it is possible to set an increasing reach time of each of the fruits stored in the fruit storing unit up to a predetermined central temperature of the fruits in a substantial concurrent manner.

[Second aspect]

In the case that the fruits stored in a certain fruit-storing unit show a delayed increasing of central temperature in the fruits in respect to the fruits stored in another fruit storing unit in reference to their contained moisture content, degree of ripen and sizes or the like, the air blower means (fan) 9 for blowing air arranged at the fruit storing unit is controlled, an amount of air of the saturated vapor (a feeding amount) per unit time passing through the fruit storing unit is increased, a heating amount is increased, thereby an increasing reach time to the predetermined central temperature of each of the fruits stored in the fruit storing unit can be set substantially in a concurrent manner.

Due to this fact, even if the central temperatures are different in their increasing in every fruit storing unit in reference to an amount of moisture contained in the stored fruits, degree of ripen and size or the like, it is possible to prevent any thermal trouble of the fruits, keep a

predetermined quality and kill the seeds and maggot of fruit fly grown at the fruits.

4. BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic front elevational view in section for showing a vapor heat insect killing device of a first preferred embodiment.

Fig. 2 is a schematic top plan view in cross section of a vapor heat insect killing device of a first preferred embodiment.

Fig. 3 is a schematic sectional view taken along line (3)-(3) of Fig. 1.

Fig. 4 is a schematic front elevational view in section for showing a vapor heat insect killing device of a second preferred embodiment.

Fig. 5 is a schematic top plan view in cross section of a vapor heat insect killing device of a second preferred embodiment.

Fig. 6 is a schematic top plan view in cross section for showing a vapor heat insect killing device of a third preferred embodiment.

5. DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to Figs. 1 to 3 showing a first preferred embodiment, Figs. 4 and 5 showing a second preferred embodiment and Fig. 6 showing a third preferred embodiment, the vapor heat insect killing apparatus for insects such as a Mediterranean fruit fly, an orange small fruit fly, a Queensland fruit fly and melon fruit fly or the like will be described as follows.

[Preferred Embodiment 1]

Then, the first preferred embodiment will be described as follows.

Figs. 1 to 3 show a preferred embodiment of the vapor heat insect killing apparatus for insects such as a Mediterranean fruit fly, an orange small fruit fly, a Queensland fruit fly and melon fruit fly or the like of the first invention, wherein reference symbol A denotes a vapor heat insect killing apparatus.

As this vapor heat insect killing apparatus A, these drawings show a constitution in which a plurality of rows (five rows in the preferred embodiment) of air circulating unit 11 comprised of an air conditioning chamber 21 and a fruit storing unit 31 communicated with the air conditioning chamber are arranged side by side within the fruit processing chamber 1 having a rectangular shape as seen in a top plan view in the

preferred embodiment.

Each of the air conditioning chambers 21 is constructed such that each of the forced circulating means (fan) 3, heat exchanging means 4 (provided with a heater, a hot water coil and a cooling coil and the like) is arranged inside the chamber with the forced circulating means 3 being installed at an upper side, and each of the air conditioning chambers is communicated with each of the adjoining fruit storing units 31 at upper side and lower side, respectively.

Reference numeral 41 denotes a damper for circulation arranged at an upper part of an interface wall 61 between each of the air conditioning chambers 21 and the fruit storing unit 31 so as to cause an upper side communicating space 51 to be released while being cooperated with the operation of either the forced circulating means 3 or the heat exchanger means 4.

In addition, each of the air conditioning chambers 21 is communicated to each other through a lower communicating space 71 opened at a lower part of the interface wall 61 for the fruit storing units 31.

Fruits B having a total amount of about 500 Kg are stored such that each of container cages 6 mounted in multi-stage states on the pallets acting as a frame 5 is separately arranged,

wherein the pallets 5 are mounted on a roller conveyor D installed over an inlet 7 and an outlet 8 provided at the opposing side walls 81, 81 of the fruit processing chamber and the fruits B are loaded into the processing chamber in response to each of the fruit storing units 31.

In addition, each of the frames (pallets) 5 as shown in the figure is abutted to each other between each of the fruit storing units 31 as described above, the place having no frame is closed by a baffle plate 91, and a space between each of the rollers (d) in the roller conveyor D below the frame 5 becomes only an air ascending space.

Each of the air conditioning chambers 21 has a temperature sensing means (a temperature sensor) C1 and a relative humidity sensing means (a relative humidity sensor) C2 at a lower position of the heat exchanger means 4. Each of the fruit-storing units 31 is provided with each of the fruit central temperature sensing means (a temperature sensor) C3 for sensing the central temperature of the fruits in the upper-most stage container cage 6.

In addition, each of the fruit-storing units 31 is provided with a humidifier acting as the vapor supplying means C4 above the upper-most stage container cage 6. The vapor supplying means C4, each of the sensing means C1, C2 and C3,

the forced circulating means 3 and the heat exchanger 4 and the like are communicated with a control unit (not shown). A vapor supplying amount and a heat-exchanging rate of the heat exchanger means are controlled by a predetermined program stored in either RAM or ROM in the control unit.

Next, referring to a control flow (not shown), an operation of the vapor heat insect killing apparatus of the first preferred embodiment will be described as follows.

When the apparatus is operated, the forced circulating means 3 and the heat exchanger means 4 mounted in each of the air conditioning chambers 21 are operated together. Air is heat exchanged (heated) by the heat exchanger means 4 in each of the air conditioning chambers 21. The air is divided to flow from the lower communicating space 71 and a space between the roller conveyor D and a floor surface and ascends. The air is fed into each of the fruit storing units 31, passes through a clearance at the frames 5, passes through the multi-stage container cages 6, its temperature is decreased by the fruits B. Upon blowing out at the upper part of the space, the air is intermittently accelerated by the vapor supplying means C4, the air is sucked again from the upper side communicating space 51 into each of the air conditioning chambers 21. After the air is conditioned (heat exchanged)

by the heat exchanger means 4, the air passes through the temperature sensing means C1 and the relative humidity sensing means C2 and again the air is fed into each of the fruit storing units 31 to form a circulating flow. There occurs scarcely that each of the divided flows is fed into the adjoining fruit storing unit 31 because each of the fruit-storing units 31 is individually communicated with the forced circulating means 3 in the air conditioning chamber 21.

In the case of performing the operation of the apparatus of the present invention, at first the increasing step 1 (an increasing mode) is executed.

At this step 1, the vapor is intermittently atomized from the vapor supplying means (a humidifier) C4, the air containing its vapor is heat exchanged by the heat exchanger 4 at a predetermined heat exchanging rate increased in a stepwise manner so as to gradually increase a relative humidity of the saturated vapor passing in each of the fruit storing units 31 and an inside temperature and then the central temperature of the fruits in each of the fruit storing units 31 is increased substantially in a concurrent manner up to a predetermined temperature (about 47.0°C) after elapsing the predetermined time.

Subsequently, a continuing step 2 is executed. This step

2 sets the predetermined central temperature of the fruits to the heat exchanging rate and the vapor supplying amount (an intermittent atomization operation) automatically selected to the heating amount required for being continuously kept, monitors an inside temperature and a relative humidity in the air circulating unit 21 for every air circulating units 11, the operation is continued for a predetermined vapor heat processing time to kill the seeds and maggot of the fruit fly grown at the fruits B.

During the aforesaid step 1, the central temperature of the fruits B in each of the fruit-storing units 31 is being chased by each of the fruit central temperature sensing means C3, and in the case that an increasing of the central temperature of the fruits in a certain fruit storing unit 31 is delayed due to the contained moisture or degree of ripen and size or the like for every measuring points (measuring time) during the chasing and a temperature difference more than the set value is detected in respect to the fruits in the fruit storing units 31 storing the fruit of the maximum fruit central temperature, the operation is transferred to the step 3.

At the step 3, the number of times of atomization from the vapor generating means C4 into the fruit storing units 31 having a delayed increasing in the central temperature of

the fruits is controlled to increase the vapor supplying amount and at the same time a heating calorie of the heat exchanger means 4 is increased so as to prevent the relative humidity from being decreased, and the central temperature of the fruits B in the fruit storing unit 31 is increased. Thus, a relative humidity of the saturated vapor passing in the fruit storing unit 31 where is delayed an increasing in central temperature of the fruits B is made higher than a relative humidity of the saturated vapor passing in the fruit storing unit 31 storing the fruit of the maximum central temperature of fruit for a predetermined period of time, an increasing of the fruit central temperature is further increased and the temperature difference of the fruit central temperature is restricted to a value lower than the set value.

This control is executed automatically every time the temperature difference of the fruit central temperature in each of the fruit storing units 31 becomes more than the set value.

When the value is restricted to a value lower than the set value, the operation returns back to the step 1 to cause the central temperature of the fruits B stored in each of the fruit storing units 31 to be increased up to a predetermined temperature (about 47.0°C) substantially in a concurrent

manner.

[Preferred Embodiment 2]

Next, referring to Figs. 4 and 5, the second preferred embodiment of the second invention will be described as follows, wherein reference symbol A denotes a vapor insect killing apparatus.

This vapor heat insect killing apparatus A is different from that shown in the first preferred embodiment in which a plurality of rows of air circulating unit 11 comprised of an air conditioning chamber 21 and a fruit storing unit 31 communicated with the air conditioning chamber are arranged side by side, the air conditioning chamber 21 is provided with the forced circulating means 3 and the heat exchanger means 4 and they can be monitored for every air circulating unit 11, wherein a plurality of fruit storing units 31 (five in the preferred embodiment) are stored in the fruit processing chamber 1, and the air conditioning chamber 21 including the forced circulating means (fan) 3 and the heat exchanger means 4 is communicated with the fruit processing chamber 1.

As shown in Fig. 5, the vapor insect killing apparatus A is constituted such that both ends of the fruit processing chamber 1 having a rectangular shape as seen in a top plan view are provided with an inlet 7 and an outlet 8, a pair of

roller conveyors D are arranged in parallel to cross the inlet 7 and the outlet 8, the frame 5 acting as the pallets is mounted over the roller conveyors D in such a way that the frame can run, and the two air conditioning chambers 21 are longitudinally communicated.

As shown in Fig. 4, each of the air conditioning chambers 21 is communicated with an upper side passage 101 and a lower side passage 111 in regard to the fruit processing chamber 1, and the forced circulating means 3, the heat exchanger means 4 (including a heater, a hot water coil and a cooling coil and the like) are arranged inside the apparatus with the forced circulating means 3 being placed upside.

As shown in Fig. 4, the fruit-storing units 31 are constituted by the container cages 6 mounted in multi-stage on the frame 5, a hood 121 arranged to cover the container cages 6 in the upper area and enabled to be moved up and down by a winding means (not shown), and an air blower means (fan) 9 for flowing air arranged in the upper part of the hood 121. The fruit-storing units are stored in the fruit-processing chamber 1 while being approached to each other by the roller conveyor D as shown. A space between each of the rollers (d) in the roller conveyor D below the frame 5 becomes only an air ascending space in the same manner as that of the aforesaid

preferred embodiment, the space ascends from a lower part toward an upper part within the container cages 6 and the air is discharged into the air processing chamber 1 under a capability of the air blower means (fan) 9 for flowing air from the hood 121.

In addition, the fruit processing chamber 1 is provided with a temperature sensing means (a temperature sensor) C1 at a forward position of the lower side passage 111 and a relative humidity sensing means (a relative humidity sensor) C2; and each of the fruit storing units 31 is provided with a fruit central temperature sensing means (a temperature sensor) C3 for sensing the central temperature of the fruits in the upper-most stage container cage 6.

In addition, a humidifier acting as the vapor supplying means C4 is arranged in the fruit processing chamber 1; the vapor supplying means C4, each of the sensing means C1, C2 and C3, the forced circulating means 3, the heat exchanger means 4 and the air blower means 9 for flowing air and the like are communicated with a control unit (not shown); and a vapor supplying amount, a heat exchanging rate of the heat exchanger means 4 and an air volume (a feeding amount) of the air blower means 9 for flowing air and the like are controlled by a predetermined program stored in either RAM or ROM in the

control unit (not shown).

Reference numeral 41 denotes a circulating damper, reference numeral 21a denotes an air suction damper and reference numeral 131 denotes an air-discharging damper.

Next, referring to a control flow (not shown), an operation of the vapor heat insect killing apparatus of the second preferred embodiment will be described as follows.

When the apparatus is operated, the forced circulating means 3, the heat exchanger means 4 and the air blower means 9 for flowing air are operated together. Air passes through the clearance of the frame 5 under an air blowing function of the air blower means 9 for flowing air, passes through the multi-stage container cages 6, shows a low temperature at the fruits B, is blown off at the hood 121, thereafter the air is intermittently humidified by the vapor supplying means C4, sucked from the upperside passage 101 into the air conditioning chambers 21, 21, conditioned (heat exchanged) by the heat exchanger means 4 and then the air passes through the temperature sensing means C1 and the relative humidity sensing means C2 and again fed into each of the fruit storing units 31 and becomes a circulating flow.

In the case of performing the operation of the apparatus of the present invention, at first the increasing step 1 (an

increasing mode) is executed.

At this step 1, the vapor is intermittently atomized from the vapor supplying means (a humidifier) C4, the air containing its vapor is heat exchanged by the heat exchanger 4 at a predetermined heat exchanging rate increased in a stepwise manner so as to gradually increase a relative humidity of the saturated vapor passing in each of the fruit storing units 31 and an inside temperature and then the central temperature of the fruits in each of the fruit storing units 31 is increased substantially in a concurrent manner up to a predetermined temperature (about 47.0°C) after elapsing the predetermined time.

Subsequently, a continuing step 2 is executed. This step 2 sets the predetermined central temperature of the fruits to the heat exchanging rate and the vapor supplying amount (an intermittent atomization operation) automatically selected to the heating amount required for being continuously kept, monitors an inside temperature and a relative humidity in the fruit processing chamber 1, the operation is continued for a predetermined vapor heat processing time to kill the seeds and maggot of the fruit fly grown at the fruits B.

During the aforesaid step 1, the central temperature of the fruits B in each of the fruit-storing units 31 is being

chased by each of the fruit central temperature sensing means C3, and in the case that an increasing of the central temperature of the fruits in a certain fruit storing unit 31 is delayed due to the contained moisture or degree of ripen and size or the like for every measuring points (measuring time) during the chasing and a temperature difference more than the set value is detected in respect to the fruits in the fruit storing units 31 storing the fruit of the maximum fruit central temperature, the operation is transferred to the step 3.

At the step 3, an air volume (a feeding amount) at the air blower means 9 for flowing air at the fruit storing unit 31 where the increasing in the fruit central temperature is slow is increased and a fruit heating calorie is increased and the central temperature of the fruits in the fruit storing unit 31 is increased. That is, a feeding amount of saturated vapor per unit time flowing in the fruit storing unit 31 is increased, a fruit heating calorie is increased and a temperature difference of the central temperatures of the fruits is restricted to the value lower than the set value.

This control is executed automatically every time the temperature difference of the fruit central temperature in each of the fruit storing units 31 becomes more than the set value.

When the value is restricted to a value lower than the set value, the operation returns back to the step 1 to cause the central temperature of the fruits B stored in each of the fruit storing units 31 to be increased up to a predetermined temperature (about 47.0°C) substantially in a concurrent manner.

[Preferred Embodiment 3]

Fig. 6 illustrates an example of modification (a third preferred embodiment) of the second preferred embodiment described above, wherein two pairs of roller conveyors D arranged in parallel to each other in such a way that they may cross against the inlet 7 and the outlet 8 of the fruit processing chamber 1, and each of the roller conveyors D, D is provided with a plurality of fruit storing units 31 (five in the preferred embodiment) in such a way that they can be run.

Each of the fruit-storing units 31 has the air blower means (fan) 9 for flowing air at the hood 121.

In the preferred embodiment, the items to be experimented in Table 2 are merely increased up to ten locations and the control is the same as that of the former one, so that its practical example is eliminated for its description.

Having described specific preferred embodiments of the

invention with reference to the accompanying drawings, it will be appreciated that the present invention is not limited to those precise embodiments, and that various changes and modifications can be effected therein by one of ordinary skill in the art without departing from the scope of the invention as defined by the appended claims.